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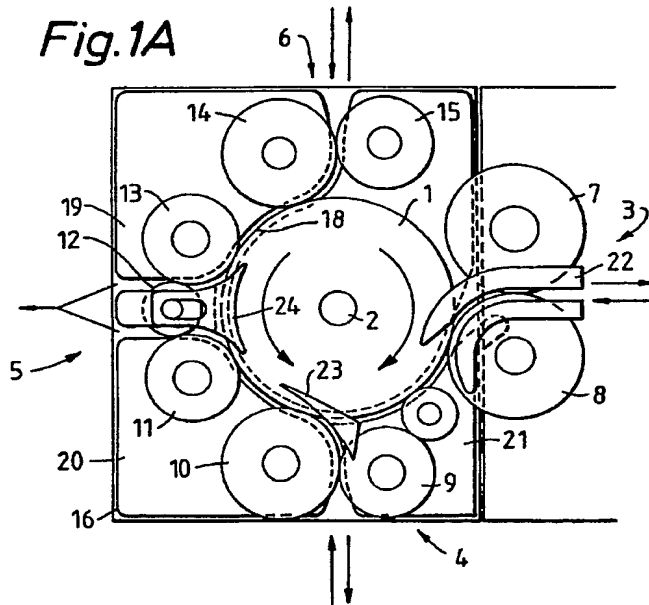
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(56) Documents Cited  
 GB 2253188 A GB 2085850 A GB 1307906 A  
 US 4871163 A

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**(54) Sheet circulation module**

(57) A sheet circulation module comprises a central roller (1) defining a sheet feed path around part of its circumference. The central roller (1) is rotatable in either direction to convey sheets in corresponding directions along the feed path. At least three sheet handling stations (3 - 6) are circumferentially spaced about and cooperate with the central roller (1), sheets entering and leaving the feed path through the sheet handling stations. The arrangement is such that sheets can be conveyed along the feed path between any of the sheet handling stations (3 - 6) by suitably rotating the central roller (1). The module is used in a bank note handling system for both dispensing and receiving and provides a compact arrangement.



**At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.**

**GB 2 280 893 A**



SHEET CIRCULATION MODULE

The invention relates to a sheet circulation module for use, for example, in banknote handling apparatus for either or both of dispensing and receiving sheets such as banknotes.

A very large number of sheet handling systems have been proposed and implemented in the past. A typical example is the system described in GB-A-1543393 which describes a modular arrangement for discharging banknotes to a dispensing station accessible to customers. Each module or magazine has a feed system and the modules are mounted together such that the feed systems cooperate to define a banknote feed path to a downstream end point. This system is limited, however, to use as a dispense system.

GB-A-2114103 describes a transport system for dispensing and receiving documents but again this is bulky and complex in construction, particularly if used to accept and dispense a number of different document sizes.

Relatively slow operating note accepting mechanisms are also known, restricted to transporting a simple range of document sizes and only able to operate on one document at a time. These exist in relatively compact forms but use the technique of pushing acceptable documents into a single store or reversing the transport drive to return unacceptable documents to the customer.

In accordance with the present invention, a sheet circulation module comprises a central roller defining a sheet feed path around part of its circumference, the central roller being rotatable in either direction to convey sheets in corresponding directions along the feed path; and at least three sheet handling stations circumferentially spaced about and cooperating with the central roller and through which sheets can enter and leave the feed path, the arrangement being such that sheets can be conveyed along the feed path between any of the sheet handling stations by suitably rotating the central roller.



We have devised a very compact module which can transport sheets or documents between any of the three or more (eg. four) stations in a very simple manner.

5 In a very simple example, two of the sheet handling stations comprise sheet input stations for supplying sheets to the feed path and the third station is a sheet exit station through which sheets leave the feed path.

10 The invention is particularly suited, however to more complex arrangements in which at least one of the sheet handling stations is able to both feed sheets to the feed path and feed sheets away from the feed path.

15 Typically, the module further comprises at least one diverter for diverting sheets from the feed path towards an associated sheet handling station. In some cases, the diverter can be fixed in position but in general the diverter will be selectively actuatable to either divert sheets or allow sheets to pass by the diverter along the feed path.

20 In some cases, the sheet feed path can extend around the whole of the circumference of the roller thus allowing, for example, sheets entering the feed path at a particular station to be conveyed around the full feed path and exit by the same station. More often, however, the sheet feed path will extend only around part of the circumference.

25 Typically, the module will further comprise guide means for guiding sheets around the sheet feed path although in other cases, for example where a vacuum feed is used, guide means may not be necessary.

30 Each sheet handling station preferably has a similar form and comprises at least a first roller cooperating with the central roller to feed sheets to and/or from the feed path. Typically, the first roller will form a nip with the central roller. Although the first roller of each sheet handling station could be driven independently of the  
35 central roller, preferably the first roller is coupled to rotate with the central roller. For example, the module may include a gear rotatable with the central roller and



gears rotatable with each first roller, the gears intermeshing.

Preferably, each sheet handling station further comprises a second roller defining a nip with the first roller through which sheets are fed.

A single sheet circulation module according to the invention can be used in a sheet handling system but the invention is particularly suited to providing a sheet handling system comprising a number of sheet circulation modules according to the invention, pairs of stations of adjacent modules being connected together to allow the passage of sheets therebetween. In this way, a relatively complex sheet handling system can be developed by using two or more circulation modules.

In either case, typically one sheet handling station is associated with a dispense or accept location, another sheet handling station is associated with a reject position, and a further sheet handling station is associated with a sheet store. This then enables documents fed from a storage area and recognised (by associated detector systems) to be unsuitable for transporting to the common note dispensing/accepting location, to be diverted into the reject or culled document position. Similarly, it enables documents accepted at the accept position and which are recognised by detector systems as being unsuitable for later dispensing to be diverted to the reject location.

An example of a banknote circulation module according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1A is a side view showing the general layout of the feed rollers of the module;

Figure 1B illustrates the drive train associated with the rollers shown in Figure 1A;

Figures 2-7 are views similar to Figure 1A but illustrating the module in different operating conditions; and,



Figure 8 illustrates a banknote handling system comprising two abutting modules of the type shown in Figure 1A.

The module shown in Figure 1A comprises a central pinch roller 1 mounted on a drive shaft 2. The roller 1 is rotatable in either direction, as shown, and cooperates with a set of four banknote handling stations 3-6 circumferentially spaced around the pinch roller. Each station 3-6 comprises a set of rollers 7-15. Each of the roller pairs 14, 15; 7, 8; 9, 10; 11, 12; and 12, 13 form a nip through which sheets can be fed upon rotation of the rollers. In addition, each of the rollers 8, 10, 11, 13 and 14 define a nip with the central, pinch roller 1.

The shafts on which all the rollers are mounted extend between side plates of the module, one of which 16 is shown in Figure 1A and typically there will be three sets of rollers in the arrangement shown in Figure 1A axially spaced along the shafts between the side plates.

The rollers are driven via respective gears 1', 7', 8', 9', 10', 11', 12', 13', 14', 15' as shown in Figure 1B, the gears being located axially outwardly of the side plate 16. The gears 8', 10', 11', 13', and 14' are driven from the gear 1' while the gear 7' is driven from the gear 8'. Drive to the central gear 1' is via a drive gear 17, the gear 9' being driven by the gear 10'. The gear 12' is driven from one of the gears 11', 13' and the gear 15' by the gear 14'.

A feed path 18 is defined around about three quarters of the circumference of the pinch roller 1 and a set of guide plates 19-21 are positioned to constrain sheets to pass along the feed path 18.

A fixed diverter 22 is positioned at the sheet handling station 3 such that upon anti-clockwise rotation of the roller 1, sheets will pass out of the feed path 18 into the diverter 22 and between the rollers 7, 8.

A movable diverter 23 is positioned at the sheet handling station 4 so that it can be selectively moved from



a bypass position shown in dotted lines into the path of sheets being conveyed in an anti-clockwise direction along the feed path 18 to guide the sheets between the rollers 9, 10.

5       A further selectively actuatable diverter 24 is provided at the sheet handling station 5 and is also movable from a position shown in solid lines in which sheets passing in either direction around the feed path 18 are guided out from the feed path to the position shown in dotted lines  
10       where sheets can pass by the station 5 around the feed path 18.

Typically, the diverters 23, 24 will be solenoid actuated in a conventional manner.

Some examples of different operating configurations of  
15       the module shown in Figure 1A will now be described. In Figure 2, the diverter 24 is moved to its divert position so that sheets entering the feed path 18 through the station 6 will be diverted between rollers 12, 13 upon anti-clockwise rotation of the central roller 1.

20       In Figure 3, the diverter 24 is in its non-divert position while the diverter 23 is in a divert position such that sheets fed into the feed path 18 from the station 6 will be carried upon anti-clockwise rotation of the pinch roller 1 past the station 5 to the station 4 where they  
25       will exit between rollers 9, 10.

In the Figure 4 configuration, both diverters 23 and 24 are positioned in their non-divert positions such that sheets entering the feed path 18 at the station 6 will be conveyed along the feed path upon anti-clockwise rotation  
30       of the roller 1 past the stations 5, 4 and then exit at the station 3 between the pinch rollers 7, 8.

Figure 5 illustrates a configuration in which sheets are fed into the feed path 18 at the station 3. The diverter 23 is in its non-divert position while the  
35       diverter 24 is in its divert position. Thus, sheets fed along the feed path 18 during clockwise rotation of the



roller 1 will be fed past the station 4 and then exit at the station 5 between rollers 11, 12.

Figure 6 illustrates an arrangement in which sheets enter the feed path 18 at the station 3 and are conveyed upon clockwise rotation of the roller 1 past the stations 4, 5 to exit at the station 6. In this case, both diverters 23, 24 are in their non-divert positions.

Finally, Figure 7 illustrates a configuration in which sheets enter the feed path 18 at the station 4, the diverter 23 being in its divert position to guide sheets into the feed path 18, the sheets being carried upon clockwise rotation of the roller 1 past the station 5 to exit at the station 6 between rollers 14, 15. The diverter 24 is in its non-divert position.

In a typical implementation, the station 3 could couple with a banknote store such as a cassette into which and from which banknotes can be fed. Examples of suitable modules which can extract banknotes from a store and stack them in the store are described in GB 9222020.1 and GB 9303093.0. Station 4 could be associated with a further transport system which can take banknotes from the module or feed banknotes into the module and a similar arrangement could be provided in association with the station 6. The station 5 could be associated with a reject or culled position.

Figure 8 illustrates an alternative system comprising two modules 30, 31 each of the type shown in Figure 1A positioned one above the other such that the station 4 of the module 30 is in communication with the station 6 of the module 31. This system would be suitable for dispensing one of two denominations of banknote for example £5 and £10 banknotes, the station 3 of the module 30 being coupled with a cassette of £5 notes and the station 3 of the module 31 being coupled with a stack of £10 notes. The station 6 of the module 30 acts as an accepting/dispensing position for accepting banknotes for storage or for dispensing banknotes. The system will be coupled with a controller,



such as a microprocessor, not shown which suitably actuates the diverters 23, 24 and rollers. Stations 5 of the modules 30, 31 are coupled with respective reject document stores for the £5 and £10 notes respectively.

5        In operation, the positions of the various accept/dispense storage points are identified to the control system for running the modules. This may occur automatically upon inserting cassettes into the feed/accept positions, or otherwise identified to the system.  
10      Likewise, the position to which the rejected documents are sent are identified to the control system.

      In an accepting mode, currency of one or mixed denominations is fed singly into a common dispense/accept point (not shown) where it is examined. If the note is  
15      unrecognisable or assessed to be a counterfeit then it may be immediately returned to the entry point or put into or diverted into a store provided for the purpose (not shown).

      If the note is recognised as either a £5 or £10 note and in a condition to be recirculated it is then transported to  
20      the station 6 of the module 30. The shafts 2 of each module, 30, 31 are rotated anti-clockwise and the diverters 24 are moved to their non-divert positions. If the incoming note is a £5, the diverter 23 is positioned in its non-divert position so that the note is carried around the  
25      feed path 18 to the station 3 of the module 30 and fed to the store (not shown). If the note is a £10, the diverter 23 is left in its divert position so that the note passes around the feed path 18 of the module 30 out through the station 4 and into the station 6 of the module 31, around  
30      the feed path 18 of the module 31 to the station 3 of the module 31 from where it is passed to a store (not shown).

      If the note is determined as unsuitable for later dispensing and is a £5, the diverter 24 in the module 30 is positioned in its divert position so that the note  
35      immediately passes to the reject store. If it is a £10 which is to be rejected, the note is passed through the module 30 into the module 31, the diverter 24 in the module



31 being set to its divert position such that the note exits at the station 5 to the reject store.

5 In a dispense mode, upon receiving a command to dispense a sum of money, for example £15, shafts 2 in both modules 30, 31 are rotated clockwise and the control system will issue an instruction to each of the stacking positions to feed one note from the respective stores towards the stations 3. Detectors (not shown) determine the satisfactory feeding of the notes whereupon the diverters 10 24 are suitably adjusted to their non-divert positions. The first, £5 note, is fed to the station 6 of the module 30 by setting the diverter 23 to its non-divert position such that the note is carried around the feed path 18 from the station 3. After that note has been dispensed, the 15 diverter 23 of the module 30 is set to its divert position and the £10 note is fed around the feed path 18 of the module 31, out through the station 6 and into the station 4 of the module 30 and then around the feed path 18 of the module 30 to the station 6.

20 In the event that the detectors find that either note has been unsatisfactorily fed, for example is a double note or the like, then the relevant diverter 24 is positioned to direct the note into the corresponding reject or cull stack position.

25 Although the configuration illustrated in Figure 8 is of two modules abutting one on top of the other to provide a vertical common path for the documents, other configurations are possible, for example horizontal. Likewise, the arrangement of stations around the central 30 roller 1 can be varied and the shaping and operation of the diverters could be exchanged or interchanged. Further, although Figure 8 shows a two module construction, any number of modules could be abutted together to form different document acceptor/dispenser configurations.

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CLAIMS

1. A sheet circulation module comprising a central roller defining a sheet feed path around part of its circumference, the central roller being rotatable in either  
5 direction to convey sheets in corresponding directions along the feed path; and at least three sheet handling stations circumferentially spaced about and cooperating with the central roller and through which sheets can enter and leave the feed path, the arrangement being such that  
10 sheets can be conveyed along the feed path between any of the sheet handling stations by suitably rotating the central roller.
2. A module according to claim 1, wherein at least one sheet handling station is adapted to feed sheets to the  
15 feed path and to feed the sheets away from the feed path.
3. A module according to claim 1 or claim 2, further comprising at least one diverter for diverting sheets from the feed path towards an associated sheet handling station.
4. A module according to claim 3, wherein the diverter is  
20 selectively actuable to either divert sheets or allow sheets to pass by the diverter along the feed path.
5. A module according to claim 3 or claim 4, wherein diverters are associated with at least two of the sheet handling stations.
- 25 6. A module according to any of the preceding claims, further comprising guide means for guiding sheets around the sheet feed path.
7. A module according to any of the preceding claims, wherein each sheet handling station comprises at least a  
30 first roller cooperating with the central roller to feed sheets to and/or from the feed path.
8. A module according to claim 7, wherein the first roller forms a nip with the central roller.
9. A module according to claim 7 or claim 8, wherein the  
35 first roller is coupled to rotate with the central roller.



10. A module according to claim 9, wherein the module includes a gear rotatable with the central roller and gears rotatable with each first roller, the gears intermeshing.
- 5 11. A module according to any of claims 7 to 10, wherein each sheet handling station further comprises a second roller defining a nip with the first roller through which sheets are fed.
- 10 12. A sheet circulation module substantially as hereinbefore described with reference to the accompanying drawings.
- 15 13. A sheet handling system comprising a sheet circulation module according to any of the preceding claims, wherein one sheet handling station is associated with a dispense or accept location, another sheet handling station is associated with a reject position, and a further sheet handling station is associated with a sheet store.
- 20 14. A sheet handling system comprising at least two sheet circulation modules according to any of claims 1 to 12, pairs of stations of adjacent modules being connected together to allow the passage of sheets therebetween.
15. A banknote handling system according to claim 13 or 14.



**Patents Act 1977**  
**Examiner's report to the Comptroller under Section 17**  
**(The Search report)**

Application number  
GB 9316663.5

- ii -

**Relevant Technical Fields**

(i) UK Cl (Ed.M) B8R (RAJ4, RAJ5, RP, RL1, RL2, RC)

(ii) Int Cl (Ed.5) B65H 29/58, 29/60

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Search Examiner  
D MCMUNN

Date of completion of Search  
30 JUNE 1994

Documents considered relevant  
following a search in respect of  
Claims :-  
1-15

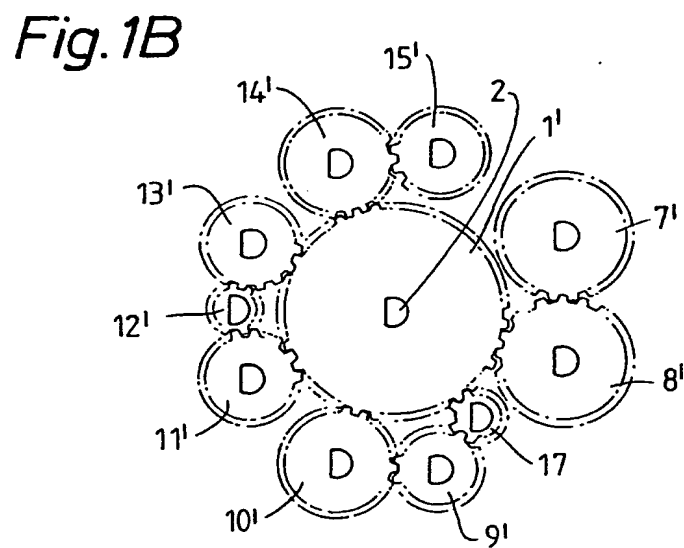
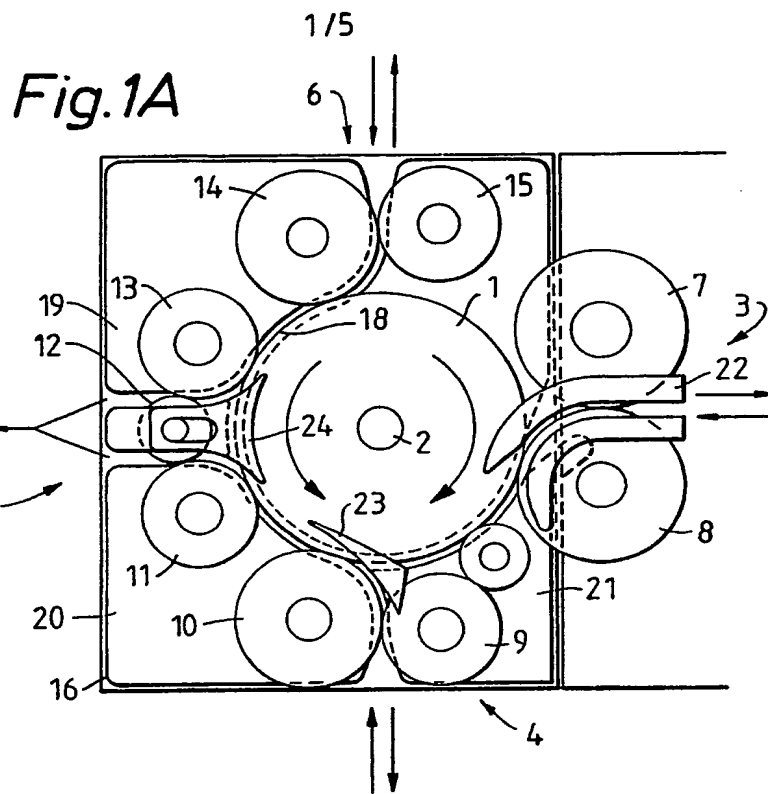
**Categories of documents**

- |  |   |
|--|---|
| <p><b>X:</b> Document indicating lack of novelty or of inventive step.</p> <p><b>Y:</b> Document indicating lack of inventive step if combined with one or more other documents of the same category.</p> <p><b>A:</b> Document indicating technological background and/or state of the art.</p> | <p><b>P:</b> Document published on or after the declared priority date but before the filing date of the present application.</p> <p><b>E:</b> Patent document published on or after, but with priority date earlier than, the filing date of the present application.</p> <p><b>&amp;:</b> Member of the same patent family; corresponding document.</p> |
|--|---|

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2253188 A	(HEIDEL BERGER) see storage drum 4, stations 1,2,21	1,3,4 , 6-10
X	GB 2085850 A	(BRANDT PRA) see roller 250	1,6,7,8
X	GB 1307906	(KODAK) see whole document	1,2,6
X	US 4871163	(SAVIN) see whole document. Mechanical equivalent	1,2,6,7

**Databases:** The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).







7 4 9 4

Fig. 2

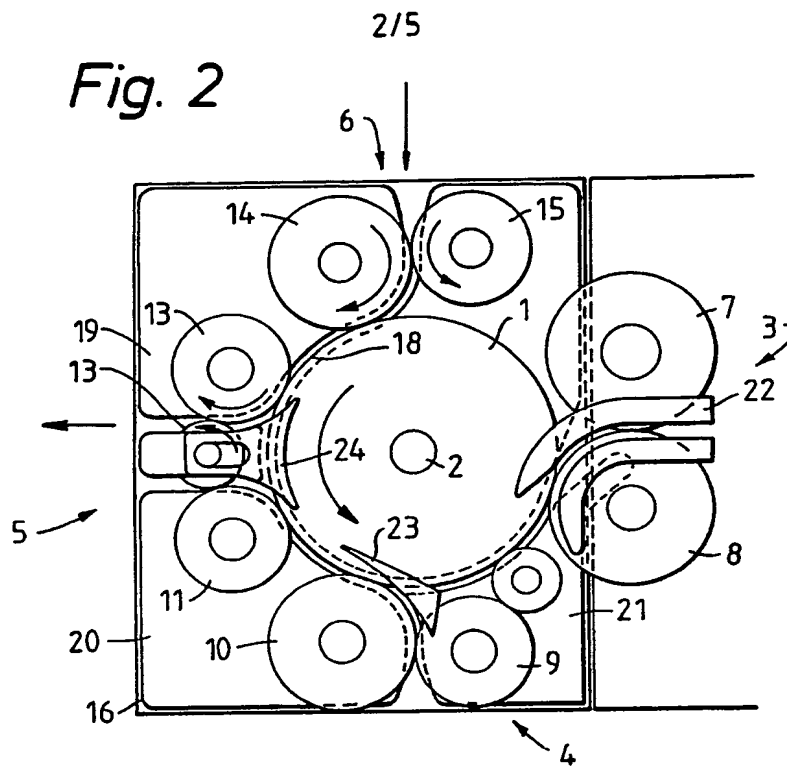


Fig. 3

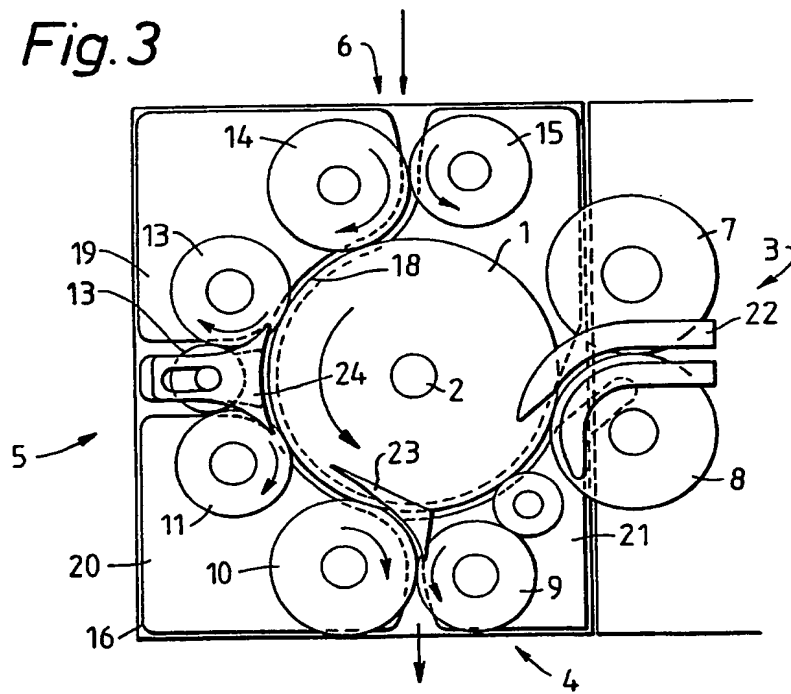




Fig. 4

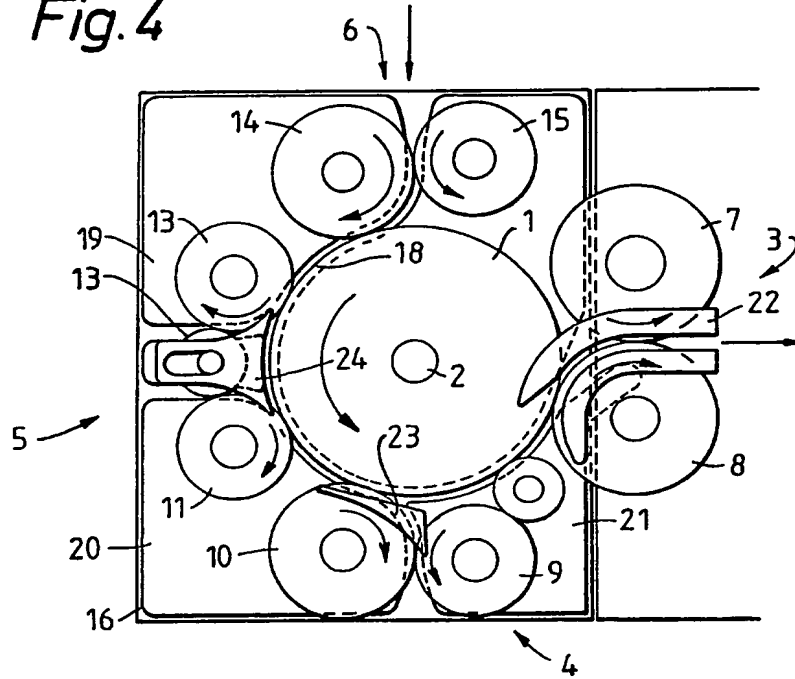
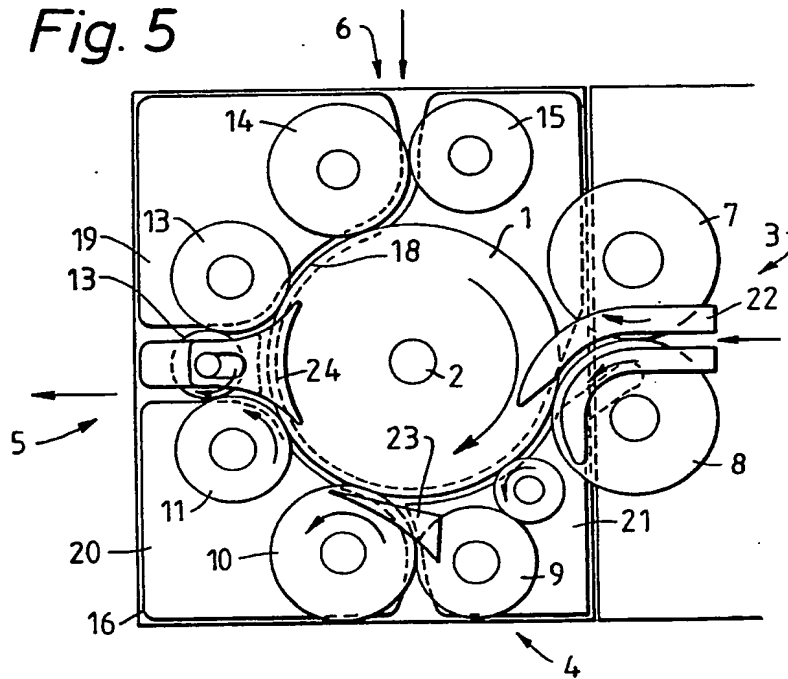


Fig. 5





**Fig. 6**



Fig.8

